200 West Mercer St. • Suite 401 • Seattle, WA 98119
Phone: 206.378.1364 • Fax: 206.973.3048 • www.windwardenv.com

MEMORANDUM

To: Rob Law (*de maximis, inc.*)

From: Suzanne Replinger, Lisa Saban, and Mike Johns (Windward Environmental)

Subject: Passaic Current Conditions Biota Sampling – Evaluation of Fish Abundance and Potential Composite Numbers

Date: May 6, 2019

This memorandum presents an evaluation of the 2009/2010 catch results for fish/crab in the Lower Passaic River Study Area (LPRSA) in order to provide context for the development of the current conditions biota sampling program that would be needed to meet the data quality objectives (DQOs) provided by the US Environmental Protection Agency (USEPA).

ANTICIPATED CATCH

The catch results for the 2009/2010 fish/crab tissue sampling and community survey work were evaluated to better inform potential catch results for the proposed target species of the current condition biota sampling (Table 1). The 2009/2010 catch results were compared with the number of composites proposed by the USEPA (i.e., 12 composites per sampling area per species in Year 1[1]) to determine whether sufficient numbers of fish/crab would be collected to meet USEPA's proposed target numbers (Table 2). USEPA's proposal includes two reaches: RM 8.3 to 15 and RM 15 to Dundee Dam.

[1] As described in the April 18, 2019, meeting minutes prepared by USEPA, USEPA's statistical power analysis for carp, perch, and eel indicated that preparing composites of three fish each was a reasonable approach, and that approximately 25 composites per species and sampling area would be necessary to detect a 50% change in concentrations of 2,3,7,8-2,3,7,8-tetrachlorodibenzo-*p*-dioxin (TCDD) (assuming 80% power, 95% confidence). Pooling data over two years was also discussed as a reasonable option to help obtain sufficient tissue mass (i.e., one-half of the samples in Year 1, one-half in Year 2).

Although it is possible that the fish community will differ from that encountered during the 2009/2010 work, the 2009/2010 data are a strong representation of what will be found during the current conditions sampling program. Assuming 3 individuals per composite (or 5 fish per composite for sunfish), the 2009/2010 community data presented in Table 2 demonstrate that insufficient numbers of fish would be collected for most species/sampling areas, as compared with the USEPA-proposed target of 12 composites per sampling area. Sufficient numbers of only blue crab (both areas), carp (river mile [RM] 8.3 to RM 15), and white perch (RM 8.3 to RM 15) were collected in 2009/2010. Based on a detailed evaluation of the fish community present above RM 8.3, the population of targeted species is insufficient to meet USEPA's proposed sampling plan.

Table 1. Summary of target sizes for species proposed for collection during current conditions biota sampling

Species[a]	Species Included	Target Size Range	Size Range to Retain During Sampling
Target species			
American eel	American eel	400–600 mm	350–700 mm
Blue crab	blue crab	125–145 mm	115–155 mm
Sunfish	bluegill, pumpkinseed, redbreast sunfish	100–140 mm	80–160 mm
Carp	common carp	500–600 mm	500–600 mm
White perch	white perch	150–200 mm	125–225 mm
Additional species			
Bass	largemouth bass, smallmouth bass	200–300 mm	> 150 mm
Catfish	channel catfish, white catfish	400–500 mm	300–600 mm

Note: Target size ranges of fish to retain during sampling were developed based on review of the 2009/2010 fish collection dataset and the analytical mass needed for the proposed analyte list. Composite samples comprising at least 100 g of tissue are targeted; a minimum of 70 g is needed for USEPA's proposed analyte list (which includes dioxins/furans, PCBs, mercury/methylmercury, select metals [copper and lead], DDX components, PAHs, and conventionals), not including potential mass lost during processing or the analytical mass needed for QC samples.

[a] The target species (i.e., eel, blue crab, sunfish, carp, and white perch) are proposed for collection for both USEPA's DQO1 and DQO2 (i.e., FWM refinement); additional species (i.e., catfish and bass) are proposed for collection only as part of DQO2.

DQO – data quality objective

FWM – food web model

PAH – polycyclic aromatic hydrocarbon

PCB – polychlorinated biphenyl

QC – quality control

USEPA – US Environmental Protection Agency

Table 2. Summary of 2009/2010 catch results

Species	Area[a]	Count by Sampling Method								Total Number Collected	Sufficient Numbers for USEPA-Proposed Composites?[b]
		Backpack Electro-fishing	Boat Electro-fishing	Crab Trap	Crayfish Trap	Gillnet	Minnow Trap	Beach Seine	Trotline		
Target species											
American eel	RM 8–RM 14	0	0	2	0	0	0	0	20	**22**	No
	RM 14–Dundee Dam	1	0	0	0	0	1	0	1	**3**	No
Blue crab	RM 8–RM 14	0	0	83	0	12	0	0	2	**97**	yes
	RM 14– Dundee Dam	2	7	18	0	14	0	0	0	**41**	yes
Carp	RM 8–RM 14	0	10	0	0	87	0	0	2	**99**	yes
	RM 14– Dundee Dam	0	8	0	0	18	0	0	1	**27**	No
Sunfish	RM 8–RM 14	0	8	5	2	1	0	5	0	**21**	No
	RM 14– Dundee Dam	12	13	1	4	0	1	0	0	**31**	No
White perch	RM 8–RM 14	0	37	7	4	9	0	3	7	**67**	yes
	RM 14– Dundee Dam	1	27	1	0	0	0	0	0	**29**	No
Additional species											
Bass	RM 8–RM 14	0	5	0	0	2	0	0	1	**8**	No
	RM 14– Dundee Dam	1	7	0	0	0	0	0	0	**8**	No
Catfish	RM 8–RM 14	0	1	0	0	2	0	0	16	**19**	No
	RM 14– Dundee Dam	0	0	0	0	9	0	0	2	**11**	No

Note: Table includes only fish within the “retain” size range specified in Table 1.

[a] Samples from 2009/2010 were collected by reach and thus could not be summarized for the proposed current conditions sampling areas RM 8.3 to RM 15 and RM 15 to RM 17.4.

[b] Determination of whether sufficient fish could be collected in each area to create the USEPA-proposed 12 composites is based on the total number of fish caught in 2009/2010 using all methods, divided by the proposed fish per composite (i.e., 3 individuals per composite for all species except sunfish, which will require 5 fish per composite).

RM – river mile

USEPA – US Environmental Protection Agency

PROPOSED CURRENT CONDITIONS SAMPLING DESIGN

Based on the anticipated catch results and evaluation of variance for the 2009/2010 samples, an adaptive sampling design is proposed. For Year 1 sampling (to be conducted in September/October 2019), the 2009/2010 data will be used to inform the numbers of samples to be collected. For Year 2 sampling (to be conducted in late summer/early fall 2020), the means and variances of the Year 1 data will be evaluated (e.g., compared with estimates from 2009/2010 data) and used to inform the numbers of samples to be collected. Year 1 and Year 2 sampling data will form the "current conditions" dataset.

Evaluation of 2009/2010 dataset

An evaluation of the TCDD and total polychlorinated biphenyl (PCB) concentrations in the 2009/2010 dataset was conducted to understand the minimum detectable difference (MDD) that potentially could be achieved, depending on the number of samples collected (assuming 80% power and 95% confidence[2]). The data for some species/chemicals were stratified above and below RM 13 to recognize that for many species (and in sediment), concentrations above this river mile are typically much less than those below it.[3]

The MDD for each target species and chemical is presented in Table 3, assuming several different sample sizes that would represent the combined 2019 and 2020 dataset. A total of 12 samples appears to be sufficient to achieve the targeted MDD of 0.5 for all species, with the exception of 2,3,7,8-TCDD concentrations in small forage fish and white perch. With regard to small forage fish, this category includes more species than just sunfish, and the inclusion of various species likely contributes to the greater variability of these data. This, along with differences in the sizes of the fish included in 2009/2010 chemistry samples further emphasize the importance of using an adaptive sampling design that uses Year 1 data to inform the remainder of the current conditions sampling program.

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[2] Power and confidence assumptions were selected to match USEPA analysis, as discussed during the April 11 and April 18, 2019, meetings.

[3] A stratified evaluation was conducted for carp (both chemicals, individual fish), crab (both chemicals), small American eel (2,3,7,8-TCDD), small forage fish (total PCBs), and white perch (total PCBs). Stratification was not done for other species due to insufficient data.

Table 3. Calculated MDD for trend analysis

Chemical	Species	CV	MDD Based on Different Sample Sizes[a]			
			n=12	n=15	n=24	n=30
2,3,7,8-TCDD	Blue crab	0.26	0.27	0.24	0.19	0.17
	Carp	0.32	0.34	0.30	0.23	0.21
	Small American eel[b]	0.38	0.40	0.35	0.28	0.25
	Small forage fish[c]	0.94	0.98	0.87	0.68	0.61
	White perch	0.60	0.63	0.56	0.44	0.39
Total PCB congeners	Blue crab	0.24	0.25	0.22	0.17	0.16
	Carp	0.14	0.15	0.13	0.10	0.09
	Small American eel[b]	0.41	0.43	0.38	0.30	0.27
	Small forage fish[c]	0.39	0.41	0.36	0.28	0.25
	White perch	0.20	0.21	0.19	0.15	0.13

[a] Power calculation assumes a one-sided, two-sample t-test with 80% power, 95% confidence, and the given sample size (n). The effect size based on those parameters was then multiplied by species-specific CV values to estimate the minimum detectable difference as a fraction of the mean (rather than the standard deviation).

[b] The small American eel category represents eel less than 50 cm in length, which is different than the size class to be targeted during the current conditions sampling. Insufficient data were available to evaluate the targeted size class.

[c] Available small forage fish data include a variety of species, including sunfish, killifish, shiner, and white perch. Current condition sampling will target only sunfish to help reduce the variance in these data.

CV – coefficient of variation
MDD – minimum detectable difference
PCB – polychlorinated biphenyl
TCDD – tetrachlorodibenzo-*p*-dioxin

Based on the 2009/2010 catch results (Table 2) and the statistical evaluation of these data (Table 3), a total of 12 samples for each targeted species over the sampling area (RM 8.3 to RM 17.4) are proposed for collection in 2019. Additional samples will be collected in 2020 to complete this dataset.

Proposed plan for Year 1 sampling

As described, a total of 12 samples for each of the target species are proposed for Year 1 sampling. The recommended distribution of these samples in the two proposed sampling areas requested by USEPA (i.e., RM 8.3 to RM 15 and RM 15 to Dundee Dam) was evaluated, as shown in Table 4. Based on the available habitat, ability of the sampling crew to access each of these areas, and the levels of 2,3,7,8-TCDD and PCB contamination in areas, 75% of the proposed number of samples will be collected in the lower area (i.e., RM 8.3 to RM 15), and 25% of the proposed number of samples will be collected in the upper area (i.e., RM 15 to Dundee Dam). If insufficient individuals are collected in one of these sampling areas (e.g., from RM 15 to Dundee Dam), additional composites may be created using individuals collected from the other sampling area (e.g., from RM 8.3 to RM 15).

Table 4. Overview of characteristics by sampling area

Characteristic	Sampling Area	
	RM 8.3 to RM 15	**RM 15 to Dundee Dam**
Habitat	Appropriate habitat is available throughout the reach.	Habitat changes exist significantly above approximately RM 16: shallower, higher flow rate, and coarser bottom composition.
Access	Entire area is accessible by boat.	The area up to approximately RM 16 can be accessed by boat; access above this area is limited to where the river can be accessed by foot.
Sampling methods	All proposed sampling methods can be used.	Sampling methods are limited above this area (backpack electrofishing, minnow traps, and beach seine).
Area size	approximately 6.7 river miles	approximately 2.7 river miles
Description of contamination	Concentrations of PCBs and TCDD in this area increase from RM 8.3 to RM 13 but decrease upstream of RM 13.	Concentrations of both PCBs and TCDD are less in this area (compared with RM 8.3 to RM 15).
Purpose for data collection	Evaluate current conditions for trend evaluation.	Confirm that concentrations in this area are less (as anticipated) for species with smaller home ranges. For species with larger home ranges (e.g., blue crab, white perch), concentrations may be similar between areas.

PCB – polychlorinated biphenyl

RM – river mile

TCDD – tetrachlorodibenzo-*p*-dioxin

Table 5 summarizes the numbers of samples to be targeted in Year 1 for each species. For each of the target species, a total of 12 composites are targeted (9 from RM 8.3 to RM 15, 3 from above RM 15). The actual number of composite samples (up to 12 per species) will depend on the number of fish/crab collected during the sampling effort. Up to a total of six composites of the additional species (i.e., bass and catfish) will also be targeted (breakdown by reach dependent on catch results).

Table 5. Proposed number of samples

Species	Target No. of Composite Samples for 2019		Tissue Types	Notes
	RM 8.3 to RM 15	RM 15 to Dundee Dam		
Target species				
American eel	9 (27 eel)	3 (9 eel)	fillet, remainder	
Blue crab	9 (27 crab)	3 (9 crab)	muscle/hepatopancreas, remainder	anticipate similar concentrations in both areas based on 2009/2010 data
Carp	9 (27 fish)	3 (9 fish)	fillet, remainder	
Sunfish	9 (45 fish)	3 (15 fish)	fillet, remainder	
White perch	9 (27 fish)	3 (9 fish)	fillet, remainder	anticipate similar concentrations in both areas based on 2009/2010 data
Additional species[a]				
Bass	TBD (based on catch); target of 6 total composites		whole body	
Catfish	TBD (based on catch); target of 6 total composites		whole body	anticipate similar concentrations in both areas based on 2009/2010 data

[a] Only whole-body samples will be analyzed since this will be sufficient to support DQO2 (i.e., FWM refinement).

DQO – data quality objective
FWM – food web model
RM – river mile
TBD – to be determined